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IS 12889 (1989): Non-destructive Testing - Performance Evaluation of Liquid Penetrants [MTD 21: Non-Destructive Testing]



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Indian Standard

**NON-DESTRUCTIVE TESTING —
PERFORMANCE EVALUATION OF LIQUID
PENETRANTS — SPECIFICATION**

भारतीय मानक

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NEW DELHI 110002

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Price Group 2

Non-Destructive Testing Sectional Committee, MTD 21

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards on 8 December 1989, after the draft finalized by the Non-Destructive Testing Sectional Committee had been approved by the Metallurgical Engineering Division Council.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

NON-DESTRUCTIVE TESTING — PERFORMANCE EVALUATION OF LIQUID PENETRANTS — SPECIFICATION

1 SCOPE

1.1 This specification covers materials used for the penetrant inspection of metal and non-porous ceramic and plastic parts to determine material discontinuities open to the surface.

2 REFERENCES

2.1 The following Indian Standards are necessary adjuncts to this standard.

<i>IS No.</i>	<i>Title</i>
1206 (Part 3) : 1978	Determination of viscosity: Part 3 Kinematic viscosity (<i>first revision</i>)
5522 : 1978	Stainless steel sheets and coils (<i>first revision</i>)

3 PENETRANT MATERIALS

3.1 The term penetrant materials shall include cleaning agents, penetrants, penetrant remover (solvents), emulsifiers, developers, etc, used in the examination process.

4 CLASSIFICATION

4.1 The penetrant inspection materials shall be of three groups. The group only denotes the family of penetrant system. The test methods are classified by the visibility of discontinuities when exposed to white light or black light and by the removability of the penetrants. Removability test for penetrants shall be done according to the methods specified in Annex A.

4.2 Group I, consisting of a solvent removable colour contrast penetrant, a penetrant remover (solvent), and a dry, wet or non-aqueous wet developer.

4.3 Group II, consisting of a water-washable (pre-emulsified) penetrant and a dry, wet or non-aqueous wet developer.

4.4 Group III, consisting of a post emulsifiable fluorescent penetrant, an emulsifier (lipophilic or hydrophilic) and a dry powder or aqueous/non-aqueous developer. The emulsifier used shall be compatible to the penetrant.

5 PHYSICAL PROPERTIES OF PENETRANT MATERIALS

5.1 Toxicity

All penetrant materials shall have no adverse effect on the health of personnel when used for its intended purpose.

5.2 Corrosive Properties

All items included in each group of material shall be non-corrosive and non-tarnishing.

5.3 Flash Point

For all penetrants, emulsifiers and wet developers other than water base ones, intended for use in open tanks or containers, the minimum flash point shall be 52°C.

5.4 Viscosity

5.4.1 The manufacturer should state the nominal viscosity of each penetrant and emulsifier. The viscosity of a particular item shall be within responsible limits for different lots. The property shall be measured in kinematic viscosity using a viscometer as specified in IS 1206 (Part 3) : 1978.

5.4.2 For penetrants, the viscosity should range from 5 to 10 centistokes at 38°C.

5.4.3 For emulsifiers, the viscosity should range from 10 to 100 centistokes at 38°C.

5.5 Storage Stability

A filled and closed container of each item of a family shall be stored for one year at the ambient temperature of the place of use without exposure to direct sunlight. At the end of the storage period, the material shall be subjected to the following tests as applicable to the item:

- a) Penetrant removability,
- b) Water washability,
- c) Precipitation rate,
- d) Developer fluorescence,
- e) Flash point,
- f) Viscosity, and
- g) Wet developer removability.

6 CONTROL OF CONTAMINANTS

6.1 All penetrant materials used on nickel-base alloys, austenitic stainless steels and titanium shall be analysed for sulphur content as they have been found to be subject to corrosion and embrittlement by contact with sulphur in the form of sulphide ions at elevated temperature.

6.2 All penetrant materials used on stainless steel and titanium shall be analysed for total halide content for the same reason stated in 6.1 due to contact with chloride ions.

6.3 For general applications, the values for total sulphur and halide content shall not exceed 1 percent each by weight. For special applications, such as, in nuclear, space, etc, the values for total sulphur and halide content shall not exceed 25 ppm each.

Methods of determining total sulphur and halide content shall be the standard test methods.

7 TEMPERATURE STABILITY

The temperature stability shall be tested by subjecting not less than 50 ml of the penetrant in a glass centrifuge tube to two complete cycles of temperature ranging from -32°C to 55°C . Each tube cycle shall extend over a minimum time period of eight hours. After the temperature cycling has been completed, the material shall be allowed to return to room temperature. The samples shall be visually examined at room temperature for any precipitation and separation of constituents.

8 WATER TOLERANCE

50 ml of the penetrant under test shall be taken in a 100 ml glass cylinder and 0.5 ml of water is added at a time using a burette and after each addition, the solution is shaken well. This process is repeated until the penetrant separates, clouds or coagulates. The amount of water added in percentage of penetrant taken gives the water tolerance for the test penetrant.

9 DEVELOPERS

9.1 All develop, dry or wet, shall provide a good contrasting white back-ground to the penetrant for which intended. Developers shall not exhibit fluorescence when exposed to ultra-violet rays at 365 nanometer (black light) wave length.

9.2 Non-Aqueous Wet Developers

9.2.1 Non-aqueous wet developers shall be solids suspended in non-aqueous liquid. They shall be ready-mixed in pressurized or non-pressurized containers. Each container shall be provided with a pallet to aid in agitation of the material and to indicate proper mixing.

9.2.2 The precipitation rate of non-aqueous wet developer shall be ascertained as follows.

The non-aqueous wet developers shall be agitated until all solids are in suspension as determined by the audible sound of the pallet in the container. For aerosol packed products, the container shall be relieved of propellant and the entire contents transferred to a suitable container for agitation to bring it to suspension. 25 ml of the developer shall then be poured into a graduated measure and allowed to stand for 15 minutes. On subsequent visual examination, the line of demarcation between the precipitate and the remaining mixture shall not be more than 2 ml below the level of the complete mixture.

9.3 Wet Developers

9.3.1 The developers shall be supplied in wet or dry condition. When supplied in dry condition, instructions for mixing shall be either marked or labelled on the container.

9.3.2 The wet developer shall be mixed in accordance with the manufacturer's instructions and allowed to stand for four hours. A 25 ml of solution shall then be poured into a graduated measure and allowed to stand for 15 minutes. After 15 minutes when visually examined, the line of demarcation between the precipitate and the remaining mixture shall not be below the half-way mark.

9.4 Dry Developers

9.4.1 Dry developer shall be light, fluffy and free from moisture and lumping.

9.4.2 To verify the 'lightness' of dry developers, a 'one litre' beaker shall be accurately weighed and the weight recorded. The beaker shall then be filled with the dry developer heated to 105°C for 1 hour and tapped lightly on the side, to cause settling of the developer. The edge of a 'spatula' or other suitable instrument shall be scrapped across the top of the beaker in such a manner that the surface of the developer is in level with the top of the beaker. The filled beaker shall then be accurately weighed. The weight of the empty beaker shall be subtracted from the total weight and the weight of the developer obtained shall not be more than 200 g.

10 SYSTEM SENSITIVITY PERFORMANCE

10.1 For consistency and reproducibility of test results, artificially produced defects shall be used to rate and compare penetrant systems and materials.

10.2 One of the following artificial defect test panels is recommended for use:

- Quench, cracked aluminium block, or
- Nickel chrome plate brass panel.

10.3 Quench-cracked Aluminium Block

10.3.1 The liquid penetrant comparator shall be made of duralumin, 12 mm thick and shall have approximate face dimensions of 50 mm × 75 mm. At the exact centre of the block, an area approximately 25 mm² in diameter shall be marked with a 510°C temperature-indicating point. The marked area is then heated with the flame impinging on the face opposite to the temperature indicating spot with a blow torch, a Bunsen burner or a similar device, to a temperature between 510 to 525°C, as indicated by the marking point. The specimen is quenched in cold water to produce a network of fine cracks on each face. Often several repeated heating and quenching operations on the same block are needed to produce adequate crack patterns. The block is finally dried by heating it approximately to 150°C.

10.3.2 A groove shall be machined across the centre of each face, 1.6 mm deep and 2 mm wide, to permit side by side comparison without interfering cross-contamination between the two sides. One half of the specimen shall be designated A and the other B for identification.

10.4 Nickel Chromium Panels

10.4.1 Alternatively, a sheet of brass, 3 mm thick, is selected and polished to a mirror finish. A thin layer of nickel is electroplated followed by a layer of chrome upon this polished surface. The chrome layer is brittle and cracks can be generated in it by stressing the other side of the panel by Brinell indentation using a 5 mm ball and 750 kg load to initiate radial cracks of 10 micrometre in width and 50 micrometre depth. For simultaneous comparison, the chrome panel can be divided into two sections by means of a longitudinal wax or narrow vinyl tape.

10.4.2 The panels shall not be bent. Flexing or bending will increase the size of existing cracks and may create new cracks.

10.5 Procedure for Use

The test penetrant is placed on one section and a standard penetrant on the other section of the cracked aluminium block or nickel chrome panels.

Based on established procedures, the sequence of application and general processing shall be identical, such as, penetrant dwell, removal and developing. The two sections shall be compared for:

- a) Completeness of crack patterns:
- b) Sharpness of crack delineation, that is, definition;
- c) Brilliance; and
- d) General visibility.

10.6 Re-use of Blocks

10.6.1 Since contaminating effect is likely to occur whenever tests are made, blocks shall never be re-used without renewing them according to the procedure outlined below.

10.6.2 Blocks used for visible dye penetrant shall not be used for fluorescent as visible dye always remains and seriously damages the performance of the fluorescent penetrant.

10.6.3 For quench cracked aluminium blocks, re-use shall be after soaking the blocks in acetone overnight, rinsing with water, reheating to 425°C slowly and quenching in cold water. The block shall be reheated moderately and allowed to cool to room temperature. Block shall not be renewed more than three times and a new aluminium block shall be prepared.

10.6.4 Other recommended methods of cleaning for re-use of the blocks includes hot aluminium alkaline cleaners, vapour degreasing and ultrasonic cleaning using proper solvents.

10.6.5 The nickel-chrome panels can be used over and over again with post cleaning after each test. Post cleaning includes ultrasonic cleaning in solvents or soaking the panel in acetone for 15 to 30 minutes followed by drying in ovens or natural drying.

11 PACKING AND MARKING

The containers of penetrant material shall bear the manufacturer's instructions for use, batch No. or lot No., date of manufacture by month and year and date of expiry in addition to the marking for conformance to this specification.

ANNEX A

(Clause 4.1)

REMOVABILITY/WASHABILITY TEST FOR PENETRANTS

A-1 REMOVABILITY TEST FOR GROUP I PENETRANT

A-1.1 Group I penetrants shall be removable by wiping with a cloth dampened with penetrant remover.

A-1.2 The penetrant remover shall be suitable commercial solvent. It shall be available in bulk or pressurized cans as specified.

A-1.3 Test Panels for Penetrant Removability

A-1.3.1 The penetrant removability shall be tested on a fairly rough surface, such as, stainless steel type (*see* IS 5522 : 1978) panels 50 mm × 100 mm in size and blasted with 150 micrometre average size grit, using 2.5 kg/cm² of air pressure with a gun held approximately 500 mm from the panels. Panels shall be slip-sheeted and wrapped for storage. Prior to use, the panels shall be vapour degreased after which they shall be heated to 100°C, then cooled to room temperature in a dessicator. The panels shall be degreased after each use.

A-1.3.2 The penetrant removability of Group I penetrant shall be tested by pouring approximately 5 ml of the reference sample on centred spots 40 mm from the top of the panel. The panel shall be allowed to drain for 15 minutes. At the end of the drain period, the panels shall be wiped with a dry cloth to remove the surplus penetrant, after which it shall be wiped with a cloth dampened with penetrant remover and dried. The applicable developer shall be applied and the panel examined under natural or white light. The penetrants shall leave substantially no more residual penetrant than that left by the reference sample.

A-2 REMOVABILITY TEST FOR GROUP II PENETRANTS

A-2.1 The test panels shall be 50 × 10 mm in size and shall be cut from clad aluminium alloy. The surface of the panels shall be in the as-rolled condition. Panels shall be slip-sheeted and wrapped

for storage. Prior to use, the panels shall be vapour degreased, after which they shall be heated to 100°C, they cooled to room temperature in a dessicator.

A-2.2 The penetrants shall be tested by pouring 2 ml of the same on the panel. The panel shall be drained at 45 degree for 15 minutes and washed in accordance with the standard washing procedure. The panels are dried in a warm air drier and coated with applicable developer and examined under natural or white light as appropriate.

A-2.3 The pannel shall be examined and there shall be no residual dye on the surface of the test panel.

A-2.4 For re-use of the panel, it shall be rinsed with water and dried after an application of methylenechloride. It shall be further soaked in dimethyl formamide, water rinsed and dried.

CAUTION — Methylene chloride and dimethyl formamide are health hazards.

A-3 GROUP III PENETRANTS

A-3.1 Test panels for Group III shall be prepared in accordance with A-1.3.

A-3.2 The penetrants shall be tested as specified in A-2.2 except after the penetrant drain period, the panel shall be dipped in the applicable emulsifier until the penetrant is covered.

A-3.3 The emulsifier shall be capable of emulsifying the penetrant and shall be suitable for application by spraying or dipping. When examined visually, the colour of the emulsifier shall be noticeably different from that of the penetrant with which they are used.

A-3.4 The emulsifier shall have a dwell time of at least 3 seconds and the panels shall be washed in accordance with the standard washing procedure. The panels are dried and coated with applicable developer and examined under natural or white light as appropriate.

A-3.5 The panel shall be examined and there shall be no residual dye on the surface of the test panel.

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